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Consistency in coastal climate adaption planning in Australia and the importance of understanding local political barriers to implementation

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ABSTRACT

The discipline of coastal climate adaptation in Australia has been increasingly practiced as communities become more aware of the likely future impacts of sea level rise. As a result, a number of coastal adaptation plans, strategies and guidelines and have been developed for coastal urban communities around the Australian coastline over the last decade. Given that a number of plans have been developed for different communities facing the same issues, it is timely to compare and contrast these plans. To this end a set of these coastal adaptation plans developed for Australian communities were compared in order to consider the variability in the recommended adaptation responses and general consistency of the plans. The adaptation responses proposed in the plans were also assessed for their ability to be implemented. Despite the similarity in the cities and towns considered in the analysis and the commonality of risk arising from sea level rise, no consistent set of adaptation recommendations arose that was common across the communities. This lack of consistency suggests a lack of understanding of the effectiveness and implement-ability of many of the proposed adaptation responses. This lack of consistency is explored here and it appears that many, if not most of the plans considered contained adaptation recommendations which will be difficult to implement.

1. Introduction

Globally, most coastal cities were originally established as coastal settlements located close to sources of freshwater and locations suitable for the establishment of ports and harbours. As a result, almost all coastal cities around the world are developed around estuaries and low-lying areas.

Creeping sea levels are therefore a threat to coastal cities and settlements worldwide (Adger et al., 2015). Whilst many coastal settlements are already exposed to catchment flooding and storm surges, sea level rise acts to amplify these events and increase the level of inundation that otherwise would have occurred. (IPCC et al., 2014; Wdowinski et al., 2016). In addition, the majority of global coastal cities were established prior to our understanding of sea level rise being available, and hence city planning was undertaken on the basis or assumption of static sea levels with the occasional perturbation associated with major storms. This effectively locked-in the development of coastal cities into low-lying regions that are now vulnerable to sea level rise (Gibbs, 2013, 2015).

Many cities around the world have recognised the threat of sea level rise in acting to increase the impacts of flooding and coastal storms. (Carson et al., 2016; Nicholls and Cazenave, 2010). In Australia, despite having relatively young cities, almost all of the major population centres are on the coast and they all host low-lying communities.

Like other coastal cities around the world, cities in Australia will increasingly be at risk from the impacts of sea level rise. In response to this rising threat many local and city governments, known in Australia as city or local councils, have commissioned coastal adaptation plans to be developed. This activity has being underway in earnest for over a decade and as a result a number of these plans have been developed.

The coastal management discipline has been providing research and management advice to coastal managers for many decades. However, the increasing awareness of sea level rise as a threat to coastal settlements has generated a new cohort of coastal climate adaptation practitioners that have especially spun out of engineering and physical sciences disciplines. More recently it has been recognised that managing sea level rise in urban environments is more than an engineering problem – it is fundamentally a social and land-use planning problem that can be supported by information derived from the physical sciences (refs, Gibbs et al., 2013). Although research and practical challenges around climate modelling, engineering design and aspects of the required harder sciences is still required, the most challenging aspects of adaptation planning often focus on questions such as how to deal with established private property rights (refs, Gibbs, 2016) and the mismatch between political timescales that are synchronised to short-term election cycles, and longer-term climate adaptation challenges.

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It can be argued that the emerging discipline of coastal climate adaptation planning is evolving from its origins in the engineering and physical sciences but has yet to formalise a set of consistent methodologies for undertaking coastal climate adaptation planning. However, in parallel it is also increasingly being recognised that there is a global lack of progress in implementing climate adaptation plans and this includes a lack of progress in implementing coastal climate adaptation plans (see for example comments in Hurlimann et al., 2014). In particular, a number of studies have recognised that although there has been a large increase in the number of adaptation plans being developed, actual on-the-ground implementation is inconsistent and the rate of progress sub-optimal when considering the scale fo the risk (Berrang-Ford et al., 2011; Preston et al., 2011; Eakin and Patt, 2011; Carmin et al., 2012; Bierbaum et al., 2012; Ford et al., 2015; Araosa et al., 2016).

Given the emergence of coastal climate adaptation planning in Australia, and the increasing recognition of a lack of progress in implementing such plans, the specific objective of the work presented here is to examine a set of coastal climate adaptation plans that have been developed for different coastal cities in Australia with similar demographics and consider how consistent and implementable the recommendations contained in the plans are. A large variance in the proposed adaptation recommendations can indicate that the adaptation approaches provided in these plans are broadly inconsistent. Such inconsistency may indicate either that tremendous innovation in adaptation responses is being considered in some cities, or alternatively that the plan developers and stakeholders that were engaged in the plan development process are unfamiliar with the implications of the adaptation options that were considered. In the latter case the likelihood of the recommendations being implemented is low; which is a common consequence arising from the development of these plans (Ford et al., 2015; Araosa et al., 2016). These results can then be used to inform the development of future adaptation plans, and provide insight into how 'settled' the discipline of coastal adaptation planning is at the present time in Australia.

2. Case studies

The thinking and analysis presented here is based around five case studies from Australia (Fig. 1). The case studies were derived from publicly available coastal adaptation plans drawn from five different coastal cities in Australia. The plans were selected so that a range of coastal cities were considered around Australia, and all plans are relatively recently developed. Despite the different locations, the socio-demographic variability among the locations of the case studies is relatively low, hence avoiding the issue highlighted by Paterson et al. (2017) whereby smaller, poorer and less developed urban settlements often feature lower adaptive capacity.

The first case study focuses on a coastal climate adaptation study for the city of Townsville in North Queensland, Australia. The second case study focuses on the city of Melbourne, on the south-eastern coast of Australia, the third on the city of Adelaide, in the state of South Australia, and the fourth case study focuses on the city of Esperance on the southern coast of the state of Western Australia. The fifth case study is located on the coastal town of Port Fairy, on the coast of the state of Victoria (Figs. 1 and 2). Readers are referred to the actual plans for complete site details.

In the following sections the adaptation options and recommendations that were considered in the plans are presented and summarised.

2.1. Townsville case study

In 2012 the Queensland State Government recognised the increasing risk of sea level rise to coastal communities in the northern Australia and commissioned a pilot coastal CHAS (Coastal Hazard Adaptation Strategy; GHD, 2012) to be developed in order to develop methods that could be applied throughout the region. The location for the pilot study was the city of Townsville, (population 168 million), a large coastal low-lying city in northern Australia (Fig. 1).

The Townsville CHAS followed a standard approach that continues to be used in Australia. This approach involves undertaking a numerical or computer modelling flood inundation study that seeks to understand future inundation risk (a flood risk assessment). The results of this flood study are then used as the basis for a community consultation exercise in order to socialise the potential risk and discuss potential adaptation options; especially to the owners of houses that may be at risk. The next tasks in these studies is to analyse the costs and benefits of the different adaptation options using a cost-benefit analysis (CBA's). The term community used here refers to the set of stakeholders that voluntary provide input into planned engagement processes.

Fig. 1. Locations of the case studies in Australia.

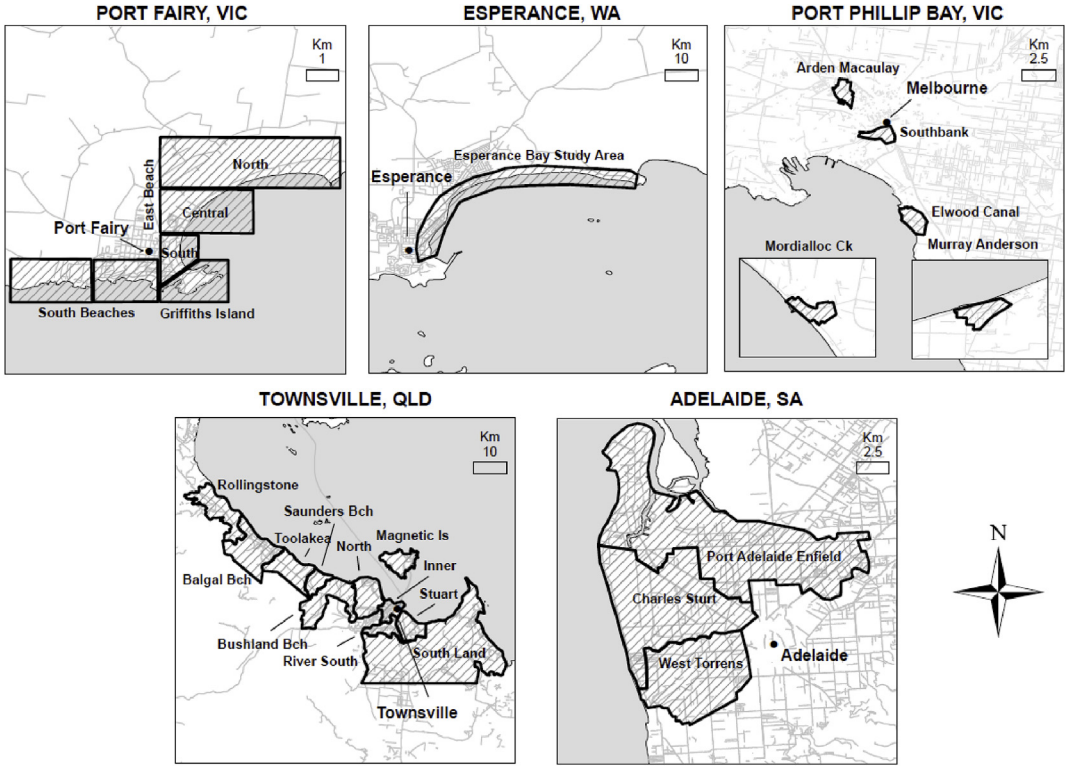

Fig. 2. Sites considered in the case studies.

This particular study considered three adaptation options for Townsville; defined in the study as follows:

Defend: Allow for development intensification by defending the current shoreline position and controlling erosion and storm tide inundation;

Accommodate: Maintain the current level of use and reduce the risk of storm tide inundation by applying innovative designs when redeveloping or upgrading existing building and infrastructure (accommodate);

Retreat: Gradually retreat buildings and infrastructure to safer grounds.

In the study the city was divided into 11 districts (Fig. 2) and community consultation was performed to develop a multi-criteria analysis (MCA) to help prioritise the options for each district. The criteria used for the MCA were: adaptation effectiveness, climate uncertainty, social and environmental impacts, and complexity and cost.

Adaptation effectiveness considered how effective each option was in protecting human life and the built environment. Climate uncertainty considered how flexible each option was in being able to accommodate uncertainty in climate projections. Social and environmental impacts considered amenity and biodiversity type values, and complexity, and cost encompassed the cost of the adaptation option.

The majority of the eleven districts considered were suburbs in which assets are dominated by private dwellings and houses (GHD, 2012). In developing the MCA with community input, the issue of who pays the costs was deliberately not explicitly considered. This has major implications to the results, as discussed below.

The results from the MCA's revealed that the preferred community option for seven out of the eleven districts was the retreat option. It can be speculated that this result is a consequence of the fact that in the MCA process community participants did not consider who would have to fund relocation of assets, and therefore it is likely that participants assumed that the cost of retreat would not be borne by themselves; thus making relocation an attractive adaptation option. This result highlights that analyses such as MCA's can be easily swayed by the wording and structure of the key assessment criteria used. This result has been well-documented elsewhere – for example see Kowalski et al. (2009).

The defend option was preferred for the remaining four districts, which included the central business district and industrial areas. It can be assumed that this result was a consequence of the high capital and economic intensity of the built environment in these locations which results in very costs for relocating these assets (the retreat option). The analysis also recommended that the optimum time to implement these options was in some cases around the year 2045, a number of decades into the future.

A CBA was then performed on the same districts using the same three adaptation options. By contrast to the results from the MCAs, for the CBAs the only adaptation options that had a positive net present value were the inner city and industrial area districts where the preferred adaptation option was to defend through coastal protection works. This is not unexpected as the cost of coastal protections works is largely dependent upon the length of coast being protected, and not the economic value of what is being protected. Expressing this a different way - the cost of coastal protection is a function of how long and high the structures are - not what they are protecting in terms of the built environment. Therefore for areas of high economic intensity, such as high-rise buildings or industrial facilities, the cost of protection quickly pales against the cost of reproducing these assets elsewhere (the retreat option).

2.2. Melbourne case study

The second case study focused on a set of residential bayside suburbs in the city of Melbourne, in South-eastern Australia (Figs. 1 and 2; AECOM, 2012). The methodology used for the Melbourne case study was similar to the Townsville CHAS study in that the project involved inundation modelling to identify assets-at-risk, a consultation task and an economic assessment of options. The economic modelling approach used in the Melbourne case study followed well-established flood and inundation modelling and assessment approaches based around the

determination of the AAD, or Average Annual Damage costs under different adaptation scenarios. The consultation component of this study focused more on consultation with local government specialists, rather than pursuing a community-based MCA assessment as used in the Townsville study.

The study considered five bayside suburbs or communities (Fig. 2). Four adaptation options were ultimately considered: accommodate, moderate protection, major protection, and retreat. These adaptation options used in the study are described below:

Accommodate: In this adaptation option flooding is allowed to occur but efforts are focused on minimising impacts when it does occur.

Moderate Protection: This option seeks to reduce the impact of current flooding by reducing its localised extent via modest or small scale engineering solutions (for example modest coastal protection).

Major protection: Eliminates the risk of future flooding through large-scale engineering solutions to allow continued use or development of the hazard zone over the longer term.

Retreat: Large-scale retreat.

Of the five suburbs that were investigated, for three the moderate protection approach was estimated to have a strong net present value, followed by a positive net present value for the accommodate approach in one suburb. The large-scale retreat approach was not considered to be of merit.

Both the Melbourne and Townsville case studies involved detailed modelling of specific communities and areas with a view to providing explicit preferred adaptation actins for each individual area. By contrast, the third case study provided more general adaptation approaches.

2.3. Western Adelaide case study

The third case study focuses on the western Adelaide region (URPS, 2016). Adelaide is the fifth largest city in Australia and is located on the coast of Southern Australia. The adaptation plan encompasses the main coastal and seaside suburbs and communities of the city of Adelaide that border the St Vincent Gulf (Fig. 2). These communities house around 22% of the total population of the city of Adelaide (around 272 thousand residents) and cover a land area of around 3900 ha.

Like the other case studies, the western Adelaide case study commissioned flood and inundation modelling, held workshops with communities and identified possible adaptation actions and options. However unlike the previous two case studies the adaptation actions did not have the granularity or resolution down to specific suburb level; rather they covered the whole domain of the study.

Interestingly the first recommendation of this study was to find alternative approaches to funding adaptation actions, in recognition that adaptation is essentially a new program to local government and hence requires new sources of funding. This is a key consideration that was likely deemed out of scope by the other two case studies.

The study was undertaken and from the study the following subsequent set of recommendations were made in order of highest to lowest priority:

- Increase urban greenness – in recognition of the urban heat island effect,
- Plan and design climate resilient buildings, places and spaces – the accommodate adaptation approach which in this case recommends the creation of a Planning and Design Code,
- Education and awareness training,
- Build community connectedness,
- Use risk assessment approaches to prioritise adaptation responses,
- Manage urban runoff to mitigate flood risk and improve water quality and reuse - also an accommodate action,
- Embed climate considerations into asset management and decision making,
- Establish soft and hard infrastructure protection measures along the coast – the protect approach to adaptation,
- Relocate assets and infrastructure away from high risk areas – the retreat approach.

The lowest priority contained in this plan was to consider relocation of both private and public assets (the retreat option). By contrast, the higher priority recommendation was accommodation type actions, especially around the design of refurbished and new structures, followed by protection (both hard and soft) measures.

2.4. Esperance case study

Esperance is major Western Australian coastal town with a population of around 13 500 residents. The town backs onto the Southern Ocean and is relatively remote. Once again in this study the three commonly used categories of adaptation response; retreat, protect, accommodate were used. In this study these were defined as follows (BMT, 2016):

Retreat: Long term retreat of key values impacted by coastal hazards involving downgrading of land use and removal of assets.

Accommodate: Long term accommodation of key values impacted by coastal hazards involving the predominant use of planning controls to maintain the level of land use.

Retreat: Long term protection of key values impacted by coastal hazards involving the predominant use of engineering controls to intensify the level of land use.

This case study considered three time periods: near-term (now), the medium–term (out to 2060) and the long-term (out to 2110), and four coastal zones that varied in intensity of urban development.

The development of this plan involved consultation with members of local government, and other relevant organisations such as the port authority and transport department. Facts sheets were distributed to the public and there was an opportunity or the public to comment on the draft plan. However formal participatory engagement with communities such as was used in the Townsville study was not used in the development of this plan.

Two main locations were considered in the study – the urbanised high-density town centre and foreshore, and lower density Castletown area. The study recommended a protect approach to the high-density urban centre and a combination of accommodate then retreat in the long-term, or accommodate then protect in the long-term for the lower density Castletown area (Fig. 2).

2.5. Port Fairy case study

Port Fairy is a coastal town on the south-east coast of Australia (Fig. 1) that has a resident population of around 300 people, that swells to around 10 000 people during the popular summer months. Initially established as a whaling port in first decades of the 20th century, the port town was developed around the estuary of the Moyne River. The settlement has suffered long term recession and coastal erosion for over a century, and hence is well accustomed to managing coastal issues. However sea level rise is expected to exacerbate these issues. In anticipation of these increasing threat, the local government commissioned the development of an adaptation plan in the form of a discussion paper.

The study (Moyne Shire Council, 2016) used the results from an earlier risk assessment undertaken by representatives from local and state government to identify locations and assets at risk. The study authors then provided the following list of possible adaptation options:

Structural measures: Relocation, raising structures and roads, retrofit or ‘retreat, elevate and armour’.

Non-structural measures: Policy changes, operational modifications, asset-specific measures.

Regional measures: Benefit multiple assets and or multiple stakeholders.

Table 1
Prioritisation of adaptation responses in the case studies.

Case Study	Adaptation Priority
Townsville	1. Large-scale retreat 2. Protect
Melbourne	1. Protect 2. Accommodate 3. Small-scale retreat
Western Adelaide	1. Accommodate 2. Protect 3. Retreat
Esperance	1. Protect/accommodate 2. Retreat/Protect
Port Fairy	1. Protect

The study authors' then proposed seven priority actions covering six at-risk coastal areas. Of these recommended actions the highest priority was the extension of an existing seawall (the protect option), followed by a recommendation to implement a beach nourishment program (also a protect option). The other proposed actions involved further studies be undertaken and an action to continue maintenance of public engineered structures that are at-risk.

2.6. Summary of the results from the case studies

Table 1 shows a summary of the adaptation summaries developed in each of the case studies. The priorities are clustered into the following commonly used categories of coastal climate adaptation; namely protect, retreat or accommodate (Bijlsma et al., 1996). This table shows how the different adaptation approaches were prioritised in each of the plans.

Inspection of Table 1 shows that each of the five case studies that the prioritisation of adaptation responses was different for all five case studies. The only commonalty among the proposed responses was that the protect response was recommended wherever high-density commercial or industrial precincts were considered.

There are two probable reasons for this general lack of consistency in recommended adaptation responses: it is possible that the communities and districts are sufficiently different to warrant different approaches to adaptation. Or alternatively, the methods as applied in the studies led to the different priorities.

The community's studied in each of the separate communities all featured a mix of high density urban development, residential suburbs and industrial areas. Therefore it is difficult to argue that differences in urban density or demographics could account for the lack of consistency in adaptation priorities. It is possible that each of the studies were biased as a result of for example different motivations, agendas, values of the stakeholders. This cannot be scientifically ruled out in that the values and preferences of each participating stakeholder was not measured (see Graham et al., 2013; Barnett et al., 2013; Spalding et al., 2014 for explanations and examples). However, from direct experience the most vocal stakeholders in public engagement processes around sea level rise consistently are home owners who perceive a risk in either new policy guidelines pertaining to sea level rise or sea level rise impacts on their assets.

By contrast, in the absence of qualitative or quantitative information on the values and preferences of individual stakeholders involved in the processes, it is argued here that methodological differences in the way the studies were undertaken led to this inconsistency. Whilst all of the studies followed the same broad process of flood modelling, developing options, stakeholder engagement and some formal analysis, there were key differences in the way that options were defined and socialised. In particular, it is possible if not probable that the lack of awareness of the political barriers to implementation and lack of understanding of the specifics of some options led to recommendations of adaptation responses that are difficult to implement; as discussed in the next section.

3. Politically tractable coastal adaptation policy instruments

It has become commonplace, especially in Australia, to categorise coastal adaptation strategies into either: planned retreat, protect, or manage/accommodate adaptation approaches – as specified in IPCC reports (beginning with Bijlsma et al., 1996). Inspection of the studies presented here supports this conclusion. However it is becoming increasing apparent that these approaches are functional strategies in that they describe the physical or functional changes that can occur to the built environment such as a new seawall or different physical arrangements of the built form. In other words they are very engineering-centric. By contrast, climate adaptation can be characterised as a social challenge and as such these functional definitions often do not convey the key information or message around the social impacts and changes that are associated with different coastal adaptation options or responses (Gibbs et al., 2013). In particular, community members who see themselves as impacted by potential changes to land use planning in the form of an adaptation plan typically raise concerns over who will pay for impacts to them, how they will be impacted, and whether they will be able to live in the same neighbourhood in the future as opposed to whether a particular adaptation response option labelled retreat, accommodate or protect is advocated (Measham et al., 2011; Sovacool et al., 2015). To this end, a slightly modified set of adaptation options that better reflect community concerns is offered here (Few et al., 2007).

Key considerations or objectives for local government can be broadly and somewhat pessimistically described as finding development or adaptation pathways that do not attract community outrage and only require limited expenditure of resources (Gibbs, 2016; Svara, 1999). One of the most effective ways of generating community outrage is to impose on private property rights and planned retreat strategies are often perceived to be doing exactly this as they lead to a major upheaval to communities. Pre-emptive planned retreat in particular is problematic as many community members only perceive the negative impacts of relocation in the face of uncertain future threat (see Gibbs, 2016 for a detailed explanation). By contrast there are rare opportunities where retreat strategies can be implemented with minimum community outrage and hence rather than rejecting all retreat options, it is suggested here that modified forms of the retreat option can be palatable to communities and hence local politicians.

The impacts of sea level rise are often most apparent during major inundation events. Such events can lead to impacts in the form of damage to both public and private assets, hardship and loss of life. However such events also represent rare opportunities to implement policy change. Immediately following such an event, local government has an opportunity to place a ban on all development in heavily impacted areas. If this requires some compensation to impacted homeowners, then this can be packaged as disaster relief, and hence avoids the moral hazard associated with planned retreat that occurs when taxes or land rates imposed upon non-impacted members of the community are used to fund the pre-emptive relocation of houses potentially at the risk in the future.

This reactive retreat approach has been implemented many times following such events as hurricanes and cyclones around the world, including for example following Hurricane Catrina and the Sandy storm in New York in 2012 (www.rebuildbydesign.org).

The other form of retreat that can be politically acceptable is when local, state or federal governments slowly purchase properties that may be at risk in the future either when they become available on the market or through forced by-back schemes. This is the covert retreat approach. The reason that this is labelled here as covert retreat is that such programs tend to be small-scale, especially in Australia, in order to both avoid a perception of moral hazard and for purely fiscal reasons – local government simply cannot afford to purchase large volumes of private

property, much of which can be high-value waterfront realty.

The protect strategy often carries little political risk as coastal protection is a well-established shoreline stabilisation approach that has been effectively used by communities for many centuries. In addition, protection strategies generally do not impact on the private property rights to those protected and can in fact increase the value of private property located behind protection (for example Jin et al., 2015). Therefore this response approach remains unchanged when local political drivers are considered although coastal protection works can be politically problematic when there is a perception that the establishment of coastal works may lead to erosion to shorelines alongside the protection works.

The accommodate or manage approach can be politically acceptable as long as the community perceives little negative impact on private property rights. A number of governments internationally have used this approach, often following large natural hazard events. In Australia following the very large floods in Brisbane in 2011 the city government immediately increased the minimum floor level specification so that any buildings being constructed or refurbished had to be set higher (Van den Honert and McAneney, 2011). However, a strategy that is generally not considered in adaptation studies is that of repurposing whereby the principal form of the built environment is slowly changed into a form that is more resilient to inundation. For example the gradual replacement of low rise individual houses to suitably designed high-rise structures with large flood immunity may be a suitable approach.

Table 2 shows a comparison of the commonly used classification for coastal climate adaptation options, titled here as functional approaches, mapped onto the politically-informed adaptation options discussed above. In this table the protect approach remains unchanged, and the accommodate approach has been reclassified into community-scale and asset-scale approaches in recognition that this strategy involves slowly nudging the at-risk built environment to be less vulnerable over time. A typical community-scale adaptation option might be to increase the capacity of the drainage system whereas a typical asset-scale accommodate initiative might be to elevate building services such as power and air-conditioning systems within the structure. This approach can also involve repurposing of land use and the form of the built environment over time to reduce the overall vulnerability. In this context community-scale.

The pre-emptive planned retreat approach, which is regarded to be politically intractable (Gibbs, 2016), is replaced in the politically-informed options of reactive retreat or the covert retreat approach. The concept of reactive retreat can be somewhat odious in the sense that it is deliberately allowing communities to be at risk from large inundation events. However, perversely as demonstrated by the global lack of multiple examples of pre-emptive retreat, it appears that politically the reactive retreat or accommodate is preferential to pre-emptive retreat (for example Jamero et al., 2017).

4. Considering the case studies in a politically-informed context

The previous section provides a modified set of adaptation options that are likely to be more politically implementable than the functional options that have been used in the case studies. In this section the prioritised adaptation recommendations from the case studies are compared to the politically-informed set of options presented above in order to assess the likelihood of implementation of the existing plans.

Table 2
Modified adaptation options.

Functional Adaptation Option	Politically-Informed Option
Planned retreat	Reactive retreat
	Covert retreat
Protect	Protect
Accommodate/manage	Community scale accommodate
	Asset scale accommodate
	Repurpose

As highlighted above, all of the case studies recommended that high-density commercial or industrial precincts be protected. This is a common recommendation and one that is being implemented worldwide – for example the major protection measures being established in New York following the Sandy Storm in 2012 (www.rebuildbydesign.org). It is also logical as the economic density of these highly developed precincts means that the cost of relocating them is generally seen to be unacceptable.

By contrast, the inconsistencies in the responses recommended in the case studies occur in lower-density residential precincts and communities where mixtures of retreat, protect and accommodate adaptation responses are proposed (Table 1). From a political perspective the second most palatable coastal adaptation approach is the accommodate option (Table 2), including both at the community and asset scale. Interestingly this option did not rate highly in the Townsville or Port Fairy case studies and was only given limited recommendation in the Melbourne case study although rated higher in the Esperance and Adelaide studies. It is speculated that this might be an artefact of a lack of direct understanding and experience of both the community members and practitioners involved in these case studies.

The accommodate response can involve both public and private actions. Public actions include increasing the capacity of the drainage network, or raising roads such as has been applied in Florida (Butler et al., 2016; Vella et al., 2016). Repurposing through amendments to planning schemes is also a community-scale accommodating approach that is likely to be widely implemented globally. However this option did not appear in any of the plans that were investigated. To this end, it is suggested here the priorities of all of the case studies may have been different if these was a greater understanding of the different politically-informed accommodate options.

The adaptation approach with most disparity is the retreat option (Rulleau and Rey-Valette, 2017). The Melbourne case study considered large scale planned retreat as not appropriate but did note that building scale retreat might have to occur. By contrast, the Townsville case study community-based MCA process recommended retreat as the preferred option for many of the lower density communities. However, this might be an artefact arising from the way the options were presented to the community-especially with regards to financial burdens of the different adaptation options.

The accommodate and protect options require decisions to be made on the level of immunity to inundation to be planned and designed for. Seawalls for example need to be constructed to a specific height above mean sea level. This implies that these options may not provide immunity to extreme sea level rise – and this is why at least one of the case studies differentiated between moderate protection and major protection. This also implies that in some cases retreat may be the only realistic option for some communities in the long-term. However the retreat option was not favoured by any of the case studies except for Townsville for communities that were not highly urbanised and it is also suggested here that this may be a consequence of the lack of politically-informed retreat options presented to the stakeholders.

In particular, none of the case studies gave credence to the reactive retreat or covert retreat options that are seen to be politically tractable. One of the reasons for this may be that although these adaptation strategies are politically tractable to implement at the appropriate time it may not be politically tractable to recommend this option in a public adaptation planning document. This is especially true for the reactive retreat option. In many ways the best opportunity for change is immediately following a large inundation event and local government can in the past, and should in the future continue with this option. However government may not feel it appropriate to publicise this in advance, which may explain the lack of this option being presented in the technical reports. The covert retreat option, whilst politically tractable when only a small number of properties are effectively re-possessed, the

small scale of this option prevents it being a realistic solution unless the scale of the adaptation problem is very small.

It then follows that there potentially could be substantially more consistency and implement-ability in the case study plans if more nuanced and politically-informed adaptation options were considered.

5. Summary and concluding remarks

A number of coastal climate adaptation plans developed in Australia were compared in order to understand the consistency in both the adaptation options considered and the ability of the recommended adaptation responses to be implemented. Almost all of the case studies used the simplistic categorisation of the adaptation responses into the functional categories of protect, retreat or accommodate response options identified in IPCC reports (Bijlsma et al., 1996). This set of functional options is in itself problematic as these definitions are very broad and contain a mixture of politically-tractable and politically-intractable adaptation options. Therefore asking both practitioners and community stakeholders to choose between these three unsophisticated choices is likely to lead to inconsistent, sub-optimal and possibly maladaptive outcomes. This is the most likely explanation for the diversity or lack of consistency in the prioritisation of the proposed adaptation responses set out in the set of case studies considered despite a high level of similarity in the communities and neighbourhoods considered in the separate plans.

The only single coherent and consistent adaptation response proposed in the case studies was for protection in highly urbanised economically-intensive precincts (Frankhauser, 1995). This response option is not only politically tractable and well understood by both practitioners and the community-at-large, it is an approach being implemented worldwide (https://theconversation.com/sea-level-rise-is-real-which-is-why-we-need-to-retreat-from-unrealistic-advice-51051). By contrast, the pre-emptive retreat option, whilst being attractive in that it de-risks communities in advance, was recommended in only one case study. Similarly, the more practical version of this, the reactive retreat option which has routinely been used globally, failed to be prioritised in any of the case studies – although this may be because although this response is politically tractable only following and event, and may in fact be politically-intractable being written in a plan (Eriksen et al., 2015).

Perhaps the most mis-understood option is the accommodate option and this may explain its lack of popularity in many of the case study plans. However once again globally this is a very-commonly applied adaptation response. For example, in low lying areas of Florida considerable efforts have gone into expanding the capacity of drainage networks to control nuisance and higher level inundation (Butler et al., 2016).

Therefore the principle result from this investigation is that the application of the new discipline of coastal climate adaptation planning in Australia is leading to a diversity of adaptation response recommendations that is perhaps unwarranted. In particular, it is argued that providing stakeholders with a choice of three simplistic, and often politically-uniformed adaptation options is artificially forcing stakeholders to prioritise adaptation options that are seen to be 'least-worst' and then hoping that it will take so long to implement any meaningful options that the issue will essentially disappear. However this results in an unintegrated adaptation plan (Stafford-Smith et al., 2016) being developed but never implemented, meaning that the risk remains unmanaged. This is known as the 'plan and forget' approach (Gibbs, 2016). It then follows that the considerations of a more nuanced set of adaptation options should lead to better engagement and community by-in, and sets of adaptation plans that can be more easily implemented.

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